Epidemiology

Epidemiology is the investigation of the prevalence (the total number of cases of disease in a population at a given time / total number of individuals in that population), etiology (source of the disease outbreak) and transmission of disease in human populations. Accordingly, an epidemic is defined as an increase in the occurrence of a disease over a given time, within a specific area or affecting a particular population. The role of an epidemiologist is to collect pertinent information about an epidemic – the causative agent, number of cases, the location and history of the disease, contributing factors, etc. These details become valuable in controlling progression of the epidemic – whether it involves development of a vaccine or other therapeutic agent, or the quarantine of infected individuals. Depending upon the morbidity rate or mortality rate of the disease, strict measures may have to be implemented to control it. US public health departments (e.g. CDC, NIH) are required to track and report many communicable diseases, e.g. avian flu, cholera, hepatitis, syphilis, etc. Such information is critical in guiding the decisions of health care officials in response to disease outbreak. In this exercise, we will simulate an infectious epidemic in the class. Your objectives will be to (1) analyze the source and transmission of the epidemic and (2) predict its impact on the class based on trends in its progression.

Procedure

1. Each student is given a plastic falcon tube (labeled with a number) that is filled with 14 ml of a clear solution that represents his/her “bodily fluid”. Using a clean transfer pipette take half a dropperful of your fluid and add it to a clean test tube (labeled 0) BEFORE you exchange fluids with another person. This will be your initial bodily fluid sample.

2. When given the signal by the instructor, each student will use a clean transfer pipette to exchange ‘fluids’ with someone at their table by putting a dropperful of his/her own solution into the other person’s test tube. Each person should only make one contact during this round and should record the name of the contact. [CAUTION: Avoid contact of the solution with skin. If you do, rinse with water and wipe up any spills on table or floor.]

3. After this first exchange, add a half dropperful of your fluid a clean test tube (labeled #1).

4. At the instructor’s signal, each student should find a second contact, exchange one dropperful of solution, record the name of the contact, and add a fluid sample to a clean test tube labeled #2.

5. At the instructor’s signal, each student should find a third contact, exchange one dropperful of solution, record the name of the contact, and add a fluid sample to a clean test tube labeled #3.

6. At the instructor’s signal, perform a fourth exchange. Your falcon tube will now serve as tube #4.

7. After 4 rounds are completed, the instructor will add diagnostic indicator to all test tubes to test for infection. The solutions of infected individuals will turn bright pink compared to the rest which remain yellowish/orange. [The diagnostic indicator is phenol red, which will turn an alkaline solution (pH > 8.2) bright pink.]

8. Pour out solutions in test tubes down sink, rinse well, and invert tubes upside down in rack to dry.

9. Working together as a class, try to analyze the spread of infection and answer the questions below.

<table>
<thead>
<tr>
<th>Table 1. Infections</th>
<th>Infected? Check the box:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>Had Contact With:</td>
</tr>
<tr>
<td>0 = original body fluid</td>
<td>YES</td>
</tr>
<tr>
<td>1 = first exchange</td>
<td></td>
</tr>
<tr>
<td>2 = second exchange</td>
<td></td>
</tr>
<tr>
<td>3 = third exchange</td>
<td></td>
</tr>
<tr>
<td>4 = fourth exchange</td>
<td></td>
</tr>
</tbody>
</table>
Questions
1. How many people were infected after
   a. round 1?
   b. round 2?
   c. round 3?
   d. round 4?

2. Can you predict the identity of the original infected individual?

Graph below the number of infected individuals per round, for all four rounds of contact.

Now use the data to predict the number of infected individuals after 5 rounds of contact.

How many rounds would be necessary to infect 50 people? 100 people?
The graph below describes the difference between **theoretical spread of infectious disease** and **actual spread of infectious disease**. In a population with very few infected individuals, the disease spreads rapidly to newly infected individuals. When the number of individuals is plotted against the number of interactions per individual, the result is an **exponential growth curve**. Essentially, the exponential growth curve predicts an infinite and “theoretical” increase in the rate of disease transmission. In reality however, the actual rate of disease transmission is limited by the number of newly infected individuals. To put it another way, disease transmission becomes limited because infected people cannot spread the disease to other people who are already infected. So in real world situations, the exponential curve gives way to a **logistic growth curve**, which becomes less steep as the number of infected increases. Examples of the two curves are show below. Notice that both are very similar when the number of interactions per person is low, but as that number climbs, the logistic curve flattens away from the exponential.

![Graph showing exponential and logistic growth curves](image)

Why would it be considered normal for the number of infected individuals to not reach its maximum (total number of individuals in population)?